*Z8 Encore MC™ Family*

# *Z8FMC16100 Series Motor Control Development Kit*

## User Manual

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# Revision History

The following table provides a revision history of this document.

| Date | Description of Change | Page(s) Affected |
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| June 2005 | Original Issue | |
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# *Introduction*

The Z8FMC16100 Series Motor Control Development Kit is designed to help you develop motor control applications using the ZiLOG 32-LQFP Z8FMC16100 Motor Control MCU. The development kit provides an application-specific platform for creating a design based on ZiLOG's Z8FMC16100 Series microcontroller. The development kit features an MC MDS module mounted on a 3-Phase Motor Control Application board. A 24VDC, 3200RPM 3-phase motor is included with the kit.

## Kit Features

The key features of the Z8FMC16100 Series Motor Control Development Kit are:

- MC MDS module
- 3-Phase Motor Control Application Board
- USB Smart Cable with optoisolator
- 3-Phase 24VDC, 30W, 3200RPM motor with spade connectors and internal Hall sensors (powered by external adjustable 24VDC supply, not included in kit)
- Universal 5VDC power supply
- Motor Control Software and Documentation CD-ROM.

For Z8FMC16100 Series Motor Control Development Kit installation and setup instructions, refer to the *Z8FMC16100 Series Motor Control Development Kit Quick Start Guide*, QS0054.

# Development Kit block Diagram

A block diagram of the Z8FMC16100 Series Motor Control Development Kit is shown in Figure 1.

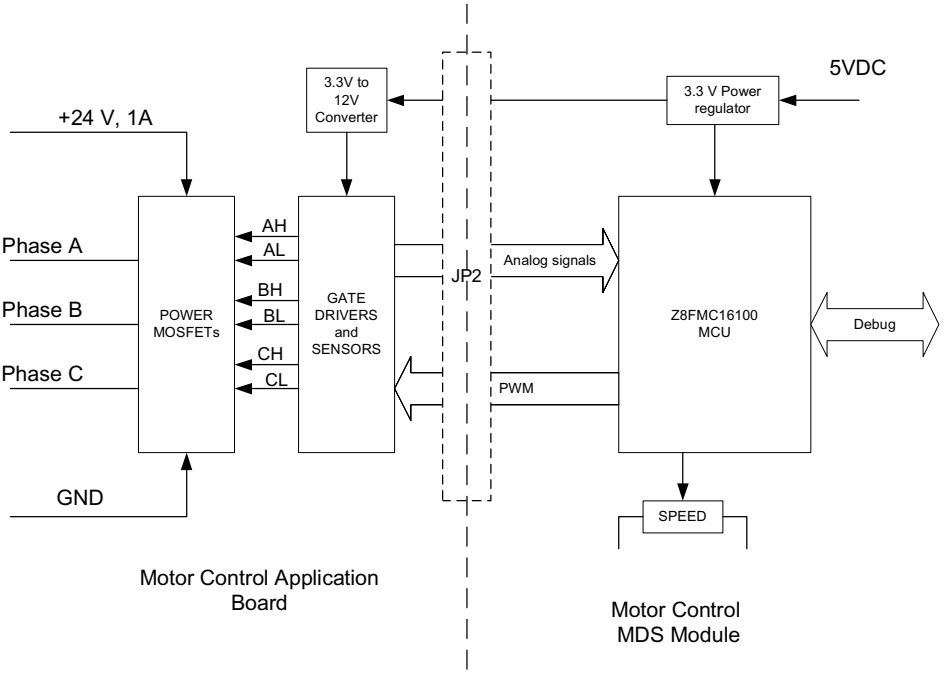


**Figure 1. FMC16100 Motor Control Development Kit**

# *MC MDS Module Description*

## Introduction

The MC MDS module (Figure 2) contains the Z8FMC16100 MCU and provides circuitry that interfaces the chip to an external development PC running the ZDS II Integrated Development Environment, and to the 3-Phase Motor Control Application Board. It also provides a prototype area for developer use.

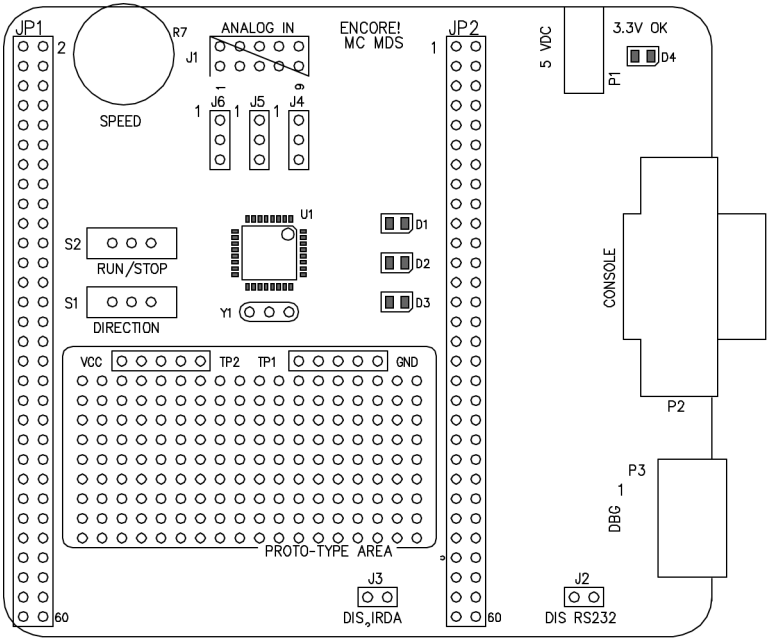


**Figure 2. MC MDS Module**

## Features

- Z8FMC16100 device operating at 20 MHz, with 16 KB of internal Flash memory and 512B of internal register SRAM
- 20MHz ceramic resonator Y1
- Two SPDT switches, S1 and S2 (labeled DIRECTION and RUN/STOP, respectively)
- One 5K potentiometer, R7 (labeled SPEED)
- Green LED D4 (illuminates when 3.3VDC is applied to the board)
- Three general-purpose LEDs D1, D2, and D3
- IRDA interface
- RS232 port
- 6-pin DBG interface
- Two 60-pin headers for connection to the 3-Phase Motor Control Application Board (JP1 and JP2; JP1 used for physical mounting only)

## MCU

The Z8FMC16100 Series Flash microcontrollers, a part of the Z8 Encore! MC® family of motor control devices, are based on ZiLOG's advanced eZ8 8-bit CPU core. Optimized for motor control applications, these devices support the control of single and multi-phase variable-speed motors. Target applications are large appliances, small appliances, and HVAC.

The Z8FMC16100 Series Motor Control Development Kit contains circuitry to support and present all the features of the Z8FMC16100 MCU. The main features of the Z8FMC16100 MCU are:

- 20 MHz ZiLOG eZ8 CPU core
- 16 KB Flash program memory
- 512 B register SRAM
- Fast 8-channel 10-bit analog-to-digital converter for current sampling and back-EMF detection
- 12-bit PWM module with three complementary pairs or six independent PWM outputs with dead-band generation and fault trip input
- One 16-bit timer with capture/compare/PWM capability
- One analog comparator for current limiting or over-current shutdown
- Operational Amplifier
- I2C in master, slave, or multimaster mode
- SPI
- UART with LIN interface
- IrDA interface with ENDEC
- Internal precision oscillator (IPO)
- Oscillator supports either internal IPO or external crystals and ceramic resonators
- Up to 17 General Purpose I/O pins (GPIO)
- Voltage Brown-Out/Power On Reset (VBO/POR)
- Watch-Dog Timer (WDT) with internal RC oscillator
- Single-pin on-chip debugger
- In-circuit serial programming

- Operating at 2.7 to 3.6 Volts
- 32-LQFP package
- Standard temperature range: 0º to 70º (S)

For further information on the Z8FMC16100 MCU consult the product specification, PS0246, or product brief, PB0166, available on the kit CD-ROM or from www.zilog.com.

## Connector JP2

Connector JP2 is a 60-pin header that connects I/O from the Z8FMC16100 MCU to the 3-Phase Motor Control Application Board.

Figure 3 illustrates the pin layout. Table 1 identifies the signals and their functions.

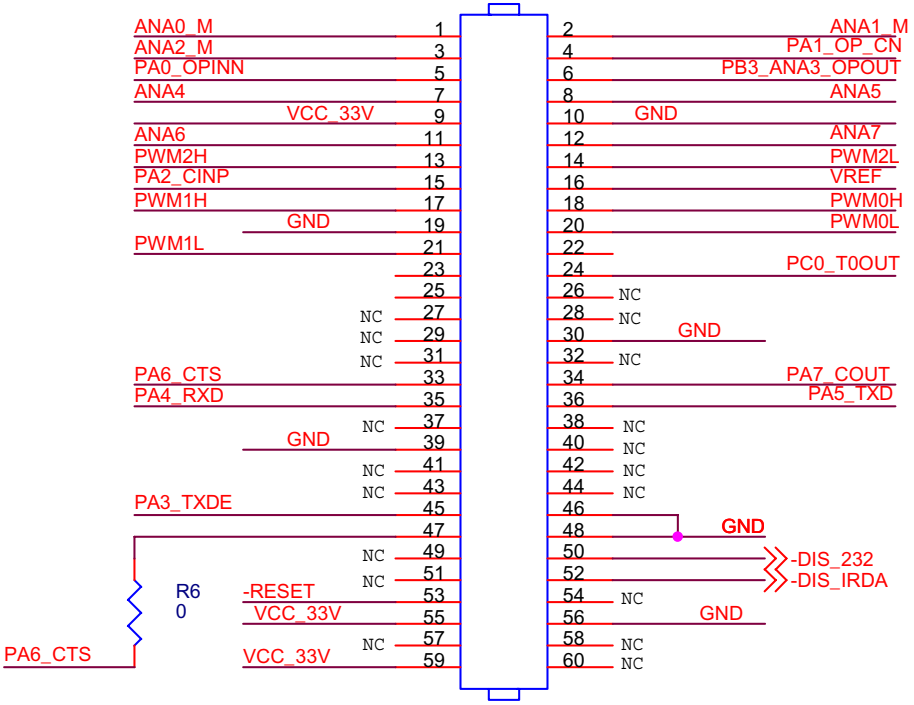


**Figure 3. MC MDS Board Connector JP2**

**Table 1. Connector JP2 Signal Descriptions**

| Signal | Pins | Direction (with respect to MCU) | Description |
|---|---|---|---|
| **General-Purpose I/O** | | | |
| PA_OP_CN<br>PA0_OPINN<br>PA2_CINP<br>PA6_CTS<br>PA7_COUT<br>PA4_RXD<br>PA5_TXD<br>PA3_TXDE | 4<br>5<br>15<br>33<br>34<br>35<br>36<br>45 | I/O | Port A[7:0]. Used for general-purpose I/O. |
| ANA0_M<br>ANA1_M<br>ANA2_M<br>PB3_ANA3_OPOUT<br>ANA4<br>ANA5<br>ANA6<br>ANA7 | 1<br>2<br>3<br>6<br>7<br>8<br>11<br>12 | I/O | Port B[7:0]. Used for general-purpose I/O. |
| PC0_T0OUT | 24 | I/O | Port C[0]. Used for general-purpose I/O. |
| **Pulse-Width Modulator for Motor Control** | | | |
| PWM2H<br>PWM1H<br>PWM0H | 13<br>17<br>18 | O | PWM High output. |
| PWM2L<br>PWM0L<br>PWM1L | 14<br>20<br>21 | O | PWM Low output. |
| PA7_COUT<br>$\overline{\text{RESET}}$ | 34<br>53 | I | PWM FAULT condition input. $\overline{\text{FAULT0}}$/ $\overline{\text{RESET}}$ is active low, FAULT1/PA7_COUT is active high. |

**Table 1. Connector JP2 Signal Descriptions**

| Signal | Pins | Direction (with respect to MCU) | Description |
|---|---|---|---|
| **Timers** | | | |
| PC0_T0OUT<br>PA7_COUT | 24<br>34 | O | General-Purpose Timer Outputs |
| ANA0_M<br>ANA1_M<br>ANA2_M | 1<br>2<br>3 | I | General-Purpose Timer Inputs. Used as the capture, gating and counter inputs. |
| **UART Controller** | | | |
| PA5_TXD | 36 | O | Transmit Data. This signal is the transmit output from the UART and IrDA. |
| PA4_RXD | 35 | I | Receive Data. This signal is the receiver input for the UART and IrDA. |
| PA6_CTS | 33 | I | Clear To Send signal from the receiving device that ready to receive data. |
| PA3_TXDE | 45 | O | Driver Enable. This signal allows automatic control of external RS-485 drivers. The DE signal may be used to ensure an external RS-485 driver is enabled when data is transmitted by the UART. |
| **Analog** | | | |
| ANA0_M<br>ANA1_M<br>ANA2_M<br>PB3_ANA3_OPOUT<br>ANA4<br>ANA5<br>ANA6<br>ANA7 | 1<br>2<br>3<br>6<br>7<br>8<br>11<br>12 | I | Analog Input. These signals are inputs to the analog-to-digital converter (ADC). |

**Table 1. Connector JP2 Signal Descriptions**

| Signal | Pins | Direction (with respect to MCU) | Description |
|---|---|---|---|
| PA2_CINP | 15 | I | Comparator positive input. |
| ANA4 | 7 | I | Comparator negative input. |
| PA7_COUT | 34 | O | Comparator out. |
| PA1_OP_CN | 4 | I | Operational amplifier positive input. |
| PA0_OPINN | 5 | I | Operational amplifier negative input. |
| PB3_ANA3_OPOUT | 6 | O | Operational amplifier output. |
| **RESET-PWM Fault** | | | |
| $\overline{\text{RESET}}$/$\overline{\text{FAULT0}}$ | 53 | I/O | $\overline{\text{RESET}}$ input pin generates a Reset or PWM fault when asserted (driven Low). The function selection is determined by the FLTSEL bit of the User Options Bits at MCU Program Memory Address 0001h, and the FAULTSEL bit in the MCU Reset Status and Control Register. |
| **Power Supply** | | | |
| VCC_33V | 9, 55, 59 | | 3.3VDC Power. |
| GND | 10,30, 39, 46, 48, 56 | | Ground. |

# Jumper and Switch Settings

The MDS Module has two SPDT switches (S1 and S2) and a 10K potentiometer (R7) that are used by the development kit's preloaded demonstration software to perform the following functions:

- S1, DIRECTION – Used to change the 3-phase motor spin direction.
- S2, RUN/STOP – Used to turn the 3-phase motor on and off.

- R7, SPEED – Used to adjust the 3-phase motor RPM.

The jumpers on the MC MDS module function as described in Table 2.

**Table 2. MC MDS Module Jumper Settings**

| Jumper | Jumper Name | Shunt Position | Function |
|---|---|---|---|
| J2 | DIS_RS232 | IN | Disables the RS-232 interface. |
| | | OUT | Enables the RS-232 interface. |
| J3 | DIS_IRDA | IN | Disables the IRDA interface. |
| | | OUT | Enables the IRDA interface. |
| J4 | J4 | 1-2 | Enables external analog input from header J1 (ANA2). |
| | | 2-3 | Disables external analog input from header J1 (ANA2). |
| J5 | J5 | 1-2 | Enables external analog input from header J1 (ANA1). |
| | | 2-3 | Disables external analog input from header J1 (ANA1). |
| J6 | J6 | 1-2 | Enables external analog input from header J1 (ANA0). |
| | | 2-3 | Disables external analog input from header J1 (ANA0). |

# Physical Dimensions

The footprint of the MC MDS module PCB is 9.14 cm x 8.12 cm. When mounted on the 3-Phase Motor Control Application Board, the overall development kit height is 4.31 cm.

# 3-Phase Motor Control Application Board

## Introduction

The 3-Phase Motor Control Application Board (Figure 4) provides circuitry that drives the 3-phase 24VDC, 3200 RPM motor included with the development kit. It provides fused 24VDC inputs for supplying external adjustable workbench power to run the motor, and interfaces the motor to the Z8FMC16100 MCU mounted on the MC MDS module.

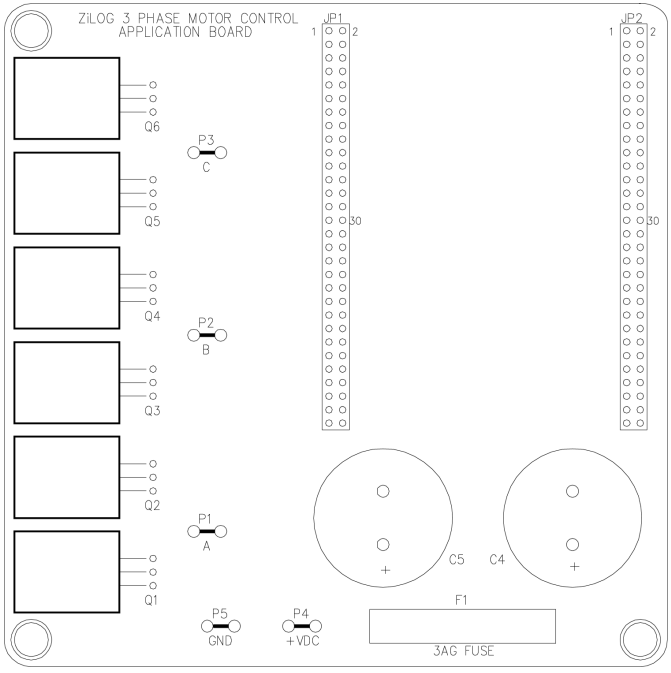


**Figure 4. 3-Phase Motor Control Application Board**

## Features

- Three spade lug connectors, one for each motor phase
- Dual power MOSFETs for each motor phase
- Heatsink temperature sensor
- Spade lug connectors for power input from adjustable 24VDC power source (for connection to 3-phase motor)
- 5A Fuse F1
- Two 60-pin headers for connection to the MC MDS module (JP1 and JP2; JP1 used for physical mounting only)

## Power MOSFETs and Gate Drivers

Each of the phase outputs on spade lugs P1, P2, and P3 are driven by a pair of power MOSFETs, one for the high side and one for the low side. A gate driver circuit is associated with each pair of power MOSFETs.

## Fused External Power Interface

An interface to an adjustable 0VDC to 24VDC workbench power supply is provided through spade lug connectors P4 (+) and P5 (-). The input power is fused through 5A 3AG fuse F1.

## Physical Dimensions

The footprint of the 3-Phase Motor Control Application Board PCB is 12.44 cm x 12.44 cm. With the MC MDS module mounted on it, the overall development kit height is 4.31 cm.

# ZDSII

The ZiLOG Developer Studio II (ZDSII) Integrated Development Environment is a complete stand-alone system that provides a state-of-the-art development environment. Based on the Windows® Win98SE/NT4.0-SP6/Win2000-SP2/WinXP user interfaces, ZDSII integrates a language-sensitive editor, project manager, C-Compiler, assembler, linker, librarian, and source-level symbolic debugger that supports the Z8FMC16100 Series device.

# *Troubleshooting and Developer Guidelines*

## Overview

Before contacting ZiLOG Customer Support to submit a problem report, please follow these simple steps. If a hardware failure is suspected, contact a local ZiLOG representative for assistance.

## Recheck Procedures Using the Quick Start Guide, QS0054

Follow the procedures in the kit quick start guide, QS0054, to verify that the kit is set up as specified.

## IrDA Port Not Working

If you plan on using the IrDA transceiver on the MC MDS module, make sure the hardware is set up as follows:

- DIS_IRDA jumper J3 must be OUT (shunt not installed) to enable the control gate that drives the IrDA device.
- DIS_RS232 jumper J2 must be IN (shunt installed) to disable the console serial port driver.

## Contacting ZiLOG Customer Support

For additional troubleshooting solutions, see ZDSII Online Help.

For valuable information about hardware and software development tools, visit ZiLOG Customer Support online. Download the latest released version of ZiLOG Developer Studio!

Get the latest software updates from ZiLOG as soon as they are available!

# *Linix Motor Wiring Information*

The Linix 3-phase motor included with the development kit provides three heavy-gauge wires for phase connections and five light-gauge wires used to power and access internal sensors.

**Table 3. 3-Phase Motor Wiring Information**

| Wire | Description |
|---|---|
| Heavy-gauge white wire | Motor Phase A connection |
| Heavy-gauge blue wire | Motor Phase B connection |
| Heavy-gauge green wire | Motor Phase C connection |
| Light-gauge red wire | Sensor power $V_{CC}$ (+) |
| Light-gauge black wire | Sensor power ground (-) |
| Light-gauge white wire | Sensor signal $S_A$ |
| Light-gauge blue wire | Sensor signal $S_B$ |
| Light-gauge green wire | Sensor signal $S_C$ |

## 3-Phase Motor Control Application Board

Figures 1 through Figure 3 provide schematics for the 3-Phase Motor Control Application Board.

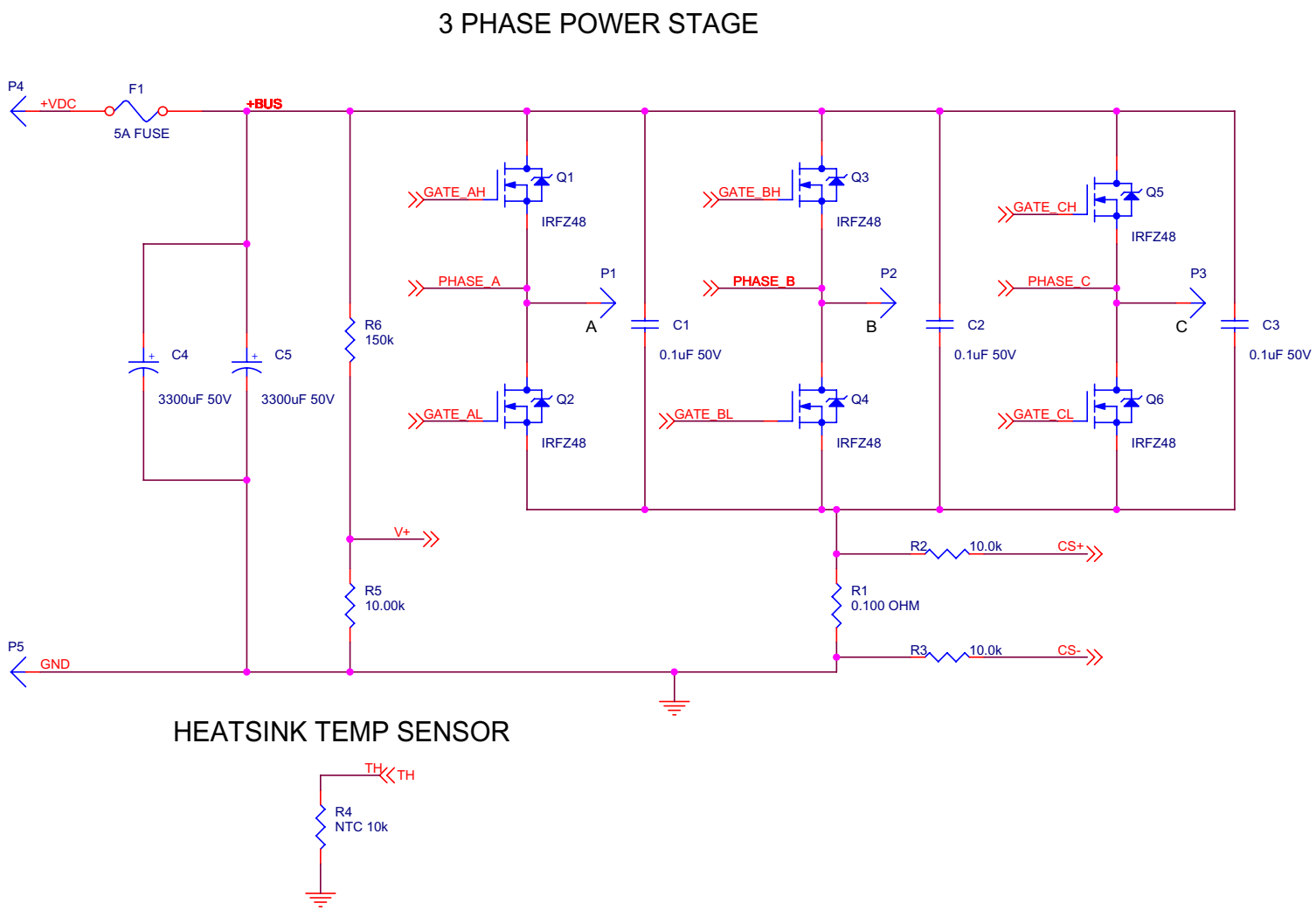


**Figure 1. 3-Phase Motor Control Application Board Schematic (1 of 3)**

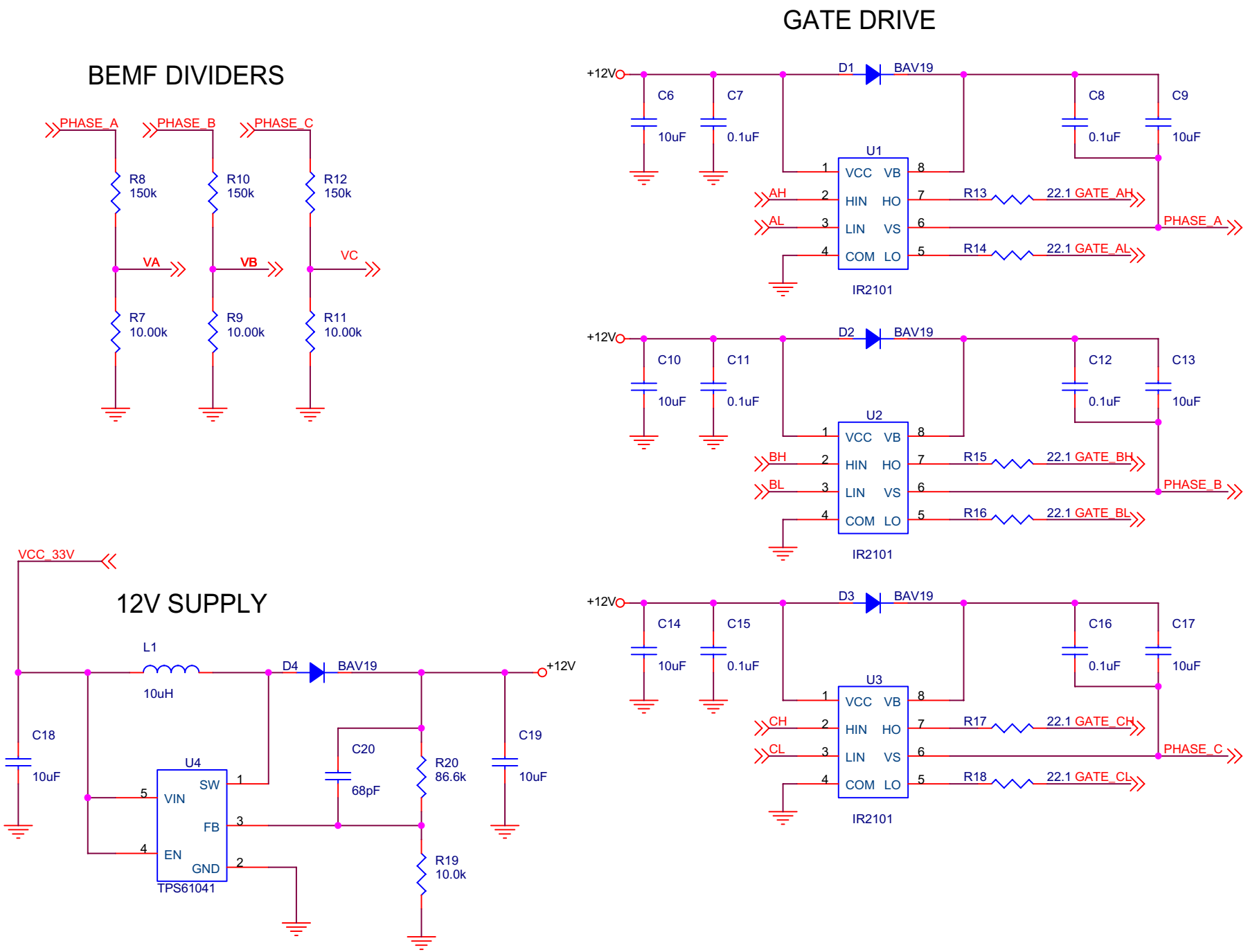


**Figure 2. 3-Phase Motor Control Application Board Schematic (2 of 3)**

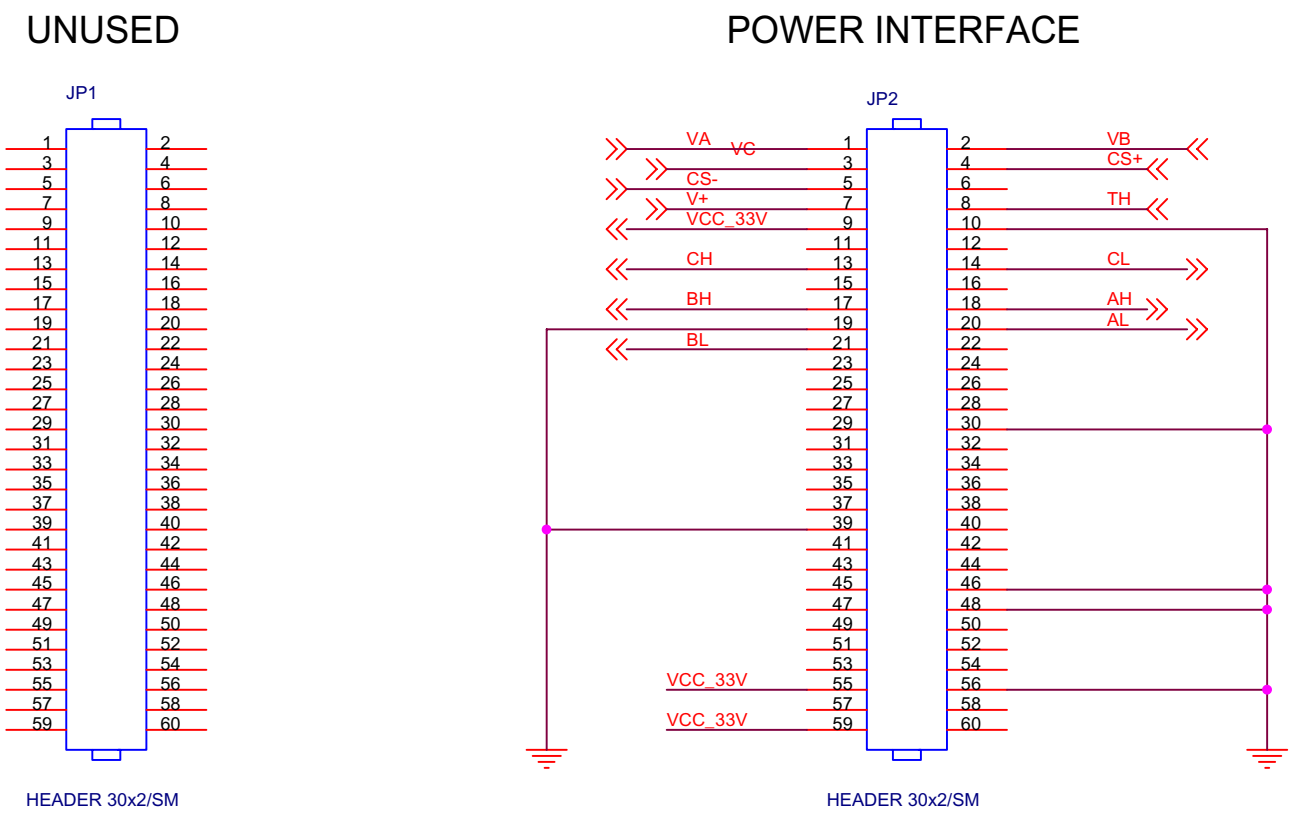


**Figure 3. 3-Phase Motor Control Application Board Schematic (3 of 3)**

## MC MDS Board

Figures 1 and 2 provide a schematic of the MC MDS Board.

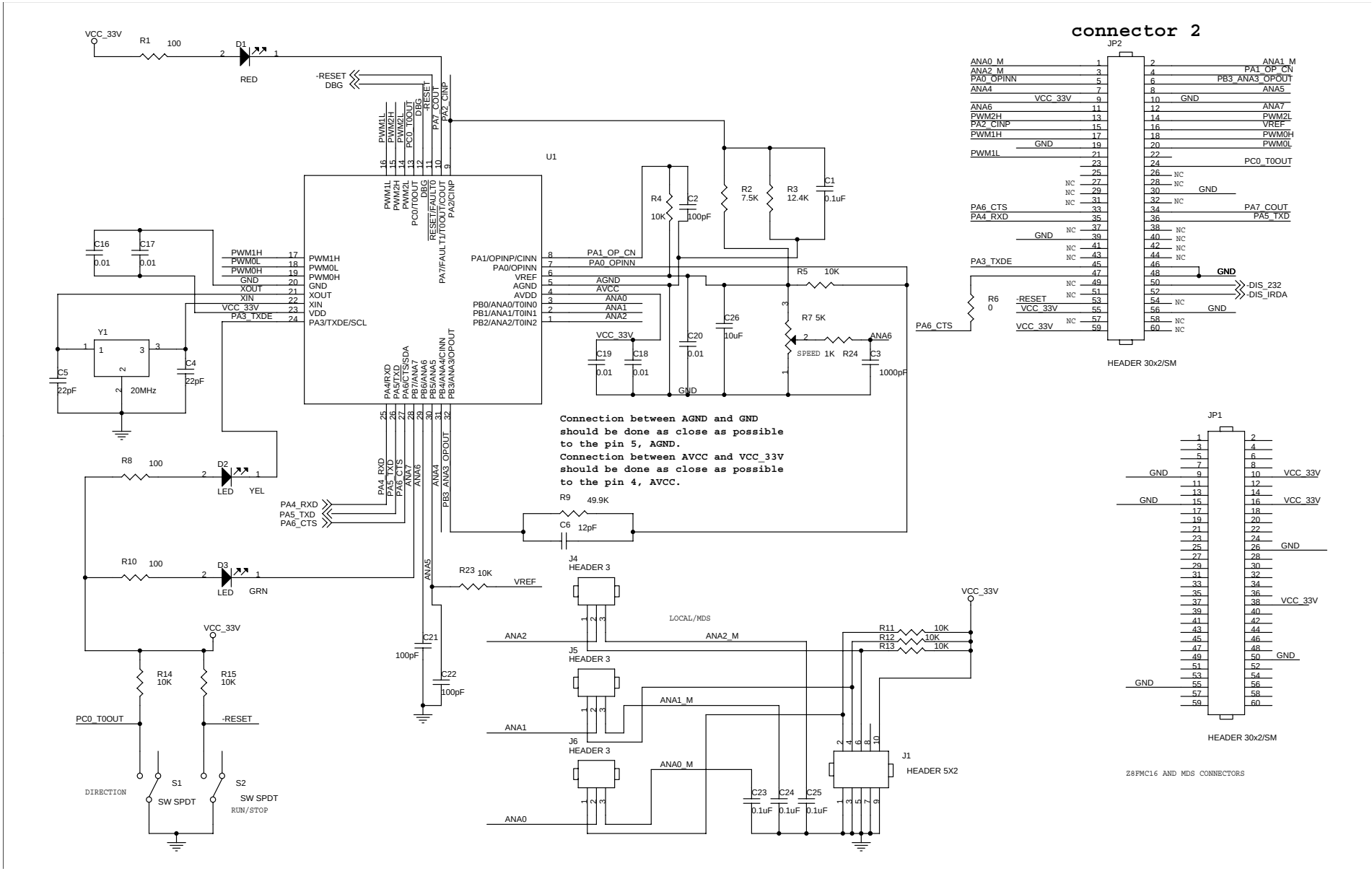


**Figure 1. MC MDS Board Schematic (1 of 2)**

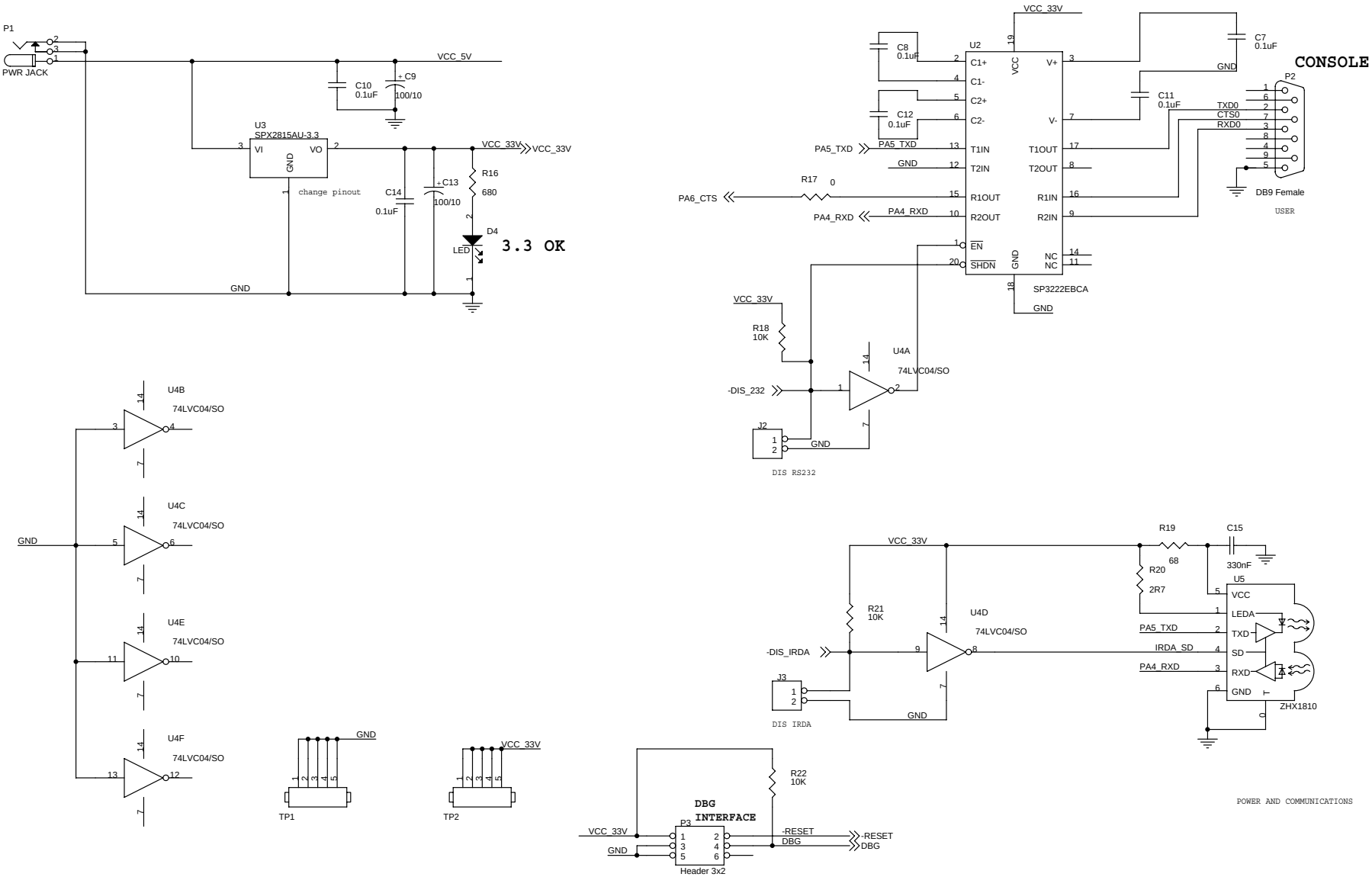


**Figure 2. MC MDS Board Schematic (2 of 2)**

# *Customer Feedback*

If you note any inaccuracies while reading this User Manual, please copy and complete this form so that we can better understand the problem you're having, then contact ZiLOG at http://www.zilog.com for return information.

**Product Information**

| |
|---|
| Z8FMC16100 Series Motor Control Development Kit |
| Serial # or Board Fab #/Rev. # |
| Software Version |
| Document Number |
| Host Computer Description/Type |

**Customer Information**

| | |
|---|---|
| Name | Country |
| Company | Phone |
| Address | Fax |
| City/State/Zip | E-Mail |

**Problem Description or Suggestion**

Provide a complete description of the problem or your suggestion. If you are reporting a specific problem, include all steps leading up to the occurrence of the problem. Attach additional pages as necessary.